DOT-TST-75-139

FORECAST OF REVENUE FREIGHT CARRIED BY RAIL IN TEXAS TO 1990

DAVID L. WILLIAMS

RESEARCH REPORT 24

APRIL 1975

DEPARTMENT OF TRANSPORTATION
OFFICE OF UNIVERSITY RESEARCH
WASHINGTON, D. C. 20590

COUNCIL FOR ADVANCED TRANSPORTATION STUDIES
THE UNIVERSITY OF TEXAS AT AUSTIN

RESEARCH REPORTS PUBLISHED BY THE COUNCIL FOR ADVANCED TRANSPORTATION STUDIES

1 *An Integrated Methodology for Estimating Demand for Essential Services with an Application to Hospital Care.* Ronald Briggs, Wayne T. Enders, James Fitzsimmons, and Paul Jensen, April 1974 (DOT-TST-75-81).

2 *Transportation Impact Studies: A Review with Emphasis on Rural Areas.* Lidvard Skorpa, Richard Dodge, C. Michael Walton, and John Huddleston, October 1974 (DOT-TST-75-59).

3 *Land Value Modeling in Rural Communities.* Lidvard Skorpa, Richard Dodge, and C. Michael Walton, June 1974 (Draft Report).

4 *Inventory of Freight Transportation in the Southwest/Part I: Major Users of Transportation in the Dallas-Fort Worth Area.* Eugene Robinson, December 1973 (DOT-TST-75-29).

5 *Inventory of Freight Transportation in the Southwest/Part II: Motor Common Carrier Service in the Dallas-Fort Worth Area.* J. Bryan Adair and James S. Wilson, December 1973 (DOT-TST-75-30).

6 *Inventory of Freight Transportation in the Southwest/Part III: Air Freight Service in the Dallas-Fort Worth Area.* J. Bryan Adair, June 1974 (DOT-TST-75-31).

7 *Political Decision Processes, Transportation Investment and Changes in Urban Land Use: A Selective Bibliography with Particular Reference to Airports and Highways.* William D. Chipman, Harry P. Wolfe, and Pat Burnett, March 1974 (DOT-TST-75-28).

8 *A Preliminary Analysis of the Effects of the Dallas-Fort Worth Regional Airport on Surface Transportation and Land Use.* Harry P. Wolfe, April 1974 (Draft Report).

9 *Dissemination of Information to Increase Use of Austin Mass Transit: A Preliminary Study.* Gene Burd, October 1973.

10 *The University of Texas at Austin: A Campus Transportation Survey.* Sandra Rosenbloom, Jane Sentilles Greig, and Lawrence Sullivan Ross, August 1973.

11 *Carpool and Bus Matching Programs for The University of Texas at Austin.* Sandra Rosenbloom and Nancy Shelton Bauer, September 1974.

12 *A Pavement Design and Management System for Forest Service Roads: A Conceptual Study.* W. R. Hudson and Thomas G. McGarragh, July 1974.

13 *Measurement of Roadway Roughness and Motion Spectra for the Automobile Highway System.* Randall Bolding, Anthony Healey, and Ronald Stearman, December 1974 (Draft Report).

14 *Dynamic Modelling for Automobile Acceleration Response and Ride Quality Over Rough Roadways.* Anthony Healey, Craig C. Smith, Ronald Stearman, and Edward Nathman, December 1974 (Draft Report).

15 *Survey of Ground Transportation Patterns at the Dallas-Fort Worth Regional Airport.* William J. Dunlay, Jr., Thomas G. Caffery, Lyndon Henry, and Douglas Wiersig, August 1975 (Draft Report).

16 *Subjective Rating of Automobile Riding Quality.* Anthony Healey and Robert Young (Draft Report forthcoming in January 1976).

17 *The Transportation Problems of the Mentally Retarded.* Shane Davies and John W. Carley, December 1974.

18 *Transportation-Related Constructs of Activity Spaces of Small Town Residents.* Pat Burnett, John Betak, David Chang, Wayne Enders and Jose Montemayor, December 1974 (DOT-TST-75-135).

19 *Marketing of Public Transportation: Method and Application.* Mark I. Alpert and Shane Davies, January 1975 (Draft Report).

20 *The Problems of Implementing a 911 Emergency Telephone Number System in a Rural Region.* Ronald T. Matthews, February 1975.

21 *A Consideration of the Impact of Motor Common Carrier Service on the Development of Rural Central Texas.* James Wilson, February 1975 (Draft Report).

22 *Modal Choice and the Value of Passenger Travel Time Literature: A Selective Bibliography.* Shane Davies and Mark I. Alpert, March 1975 (Draft Report).

23 *Forecast of Truckload Freight of Class I Motor Carriers of Property.* Mary Lee Gorse, March 1975 (DOT-TST-75-138).

24 *Forecast of Revenue Freight Carried by Rail in Texas to 1990.* David L. Williams, April 1975 (DOT-TST-75-139).

FORECAST OF REVENUE FREIGHT CARRIED BY RAIL IN TEXAS TO 1990

David L. Williams

APRIL 1975

RESEARCH REPORT

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22151

Prepared for

Council for Advanced Transportation Studies
The University of Texas at Austin
Austin, Texas 78712

In cooperation with

Department of Transportation
Office of University Research
Washington, D.C. 20590

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle

FORECAST OF REVENUE FREIGHT CARRIED BY RAIL IN TEXAS TO 1990

5. Report Date

April 1975

6. Performing Organization Code

7. Author(s)

David L. Williams

8. Performing Organization Report No.

RR 24

9. Performing Organization Name and Address

Council for Advanced Transportation Studies
The University of Texas at Austin
Austin, Texas 78712

10. Work Unit No. (TRAIS)

00 3655 8

11. Contract or Grant No.

DOT-OS-30093

12. Sponsoring Agency Name and Address

Department of Transportation
Office of University Research
Washington, D.C. 20590

13. Type of Report and Period Covered

Research Report

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Revenue tons of freight carried by rail in Texas have been forecast to 1990 using multiple regression analysis and trend analysis. Data were gathered on the dependent variable (revenue tons of freight carried by rail in Texas) and on twenty-nine independent variables (economic indicators of the Texas economy) for the base period 1950 to 1972.

Missing values from the time series data were estimated with the aid of the OMNITAB computer program POLYFIT. Multiple regression analyses were used to measure the linear relationship between the dependent variable and a set of independent variables, taking into consideration the interrelationships between the independent variables. From these analyses, a set of ten independent variables was selected as providing the best predictor regression equation.

Forecasts for each of the ten selected variables were computed for 1975, 1980, 1985, and 1990 by extrapolating a chosen trend curve. These forecasted values were then substituted into the regression equation to yield forecasts for the tons of revenue freight carried by rail in Texas.

17. Key Words	18. Distribution Statement
Rail freight, Forecasting, Multiple regression analysis, Trend analysis	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	53	

EXECUTIVE SUMMARY

Introduction

This is the third in a series of reports designed to forecast future demand for various modes of transportation in Texas and the West South Central states. Reports already published are _A Forecast of Air Cargo Originations in Texas to 1990_ and _Forecast of Truckload Freight of Class I Motor Carriers of Property in the Southwestern Region to 1990_, both by Mary Gorse. Other reports in the series include a forecast of air cargo originations in Arkansas, Louisiana, and Oklahoma, and a forecast of pipeline movements.

Problem Studied

Revenue tons of freight carried by rail in Texas have been forecasted to 1990 using multiple regression analysis and trend analysis. This methodology was used initially in _A Forecast of Air Cargo Originations in Texas to 1990_ and has been modified slightly in order to develop the forecasts for truckload freight and rail freight. While this report was confined to a forecast of revenue freight carried by rail in Texas, the methodology is equally applicable to other states, provided the necessary data on the variables can be obtained. For a more complete explanation of the forecasting procedures readers are referred to the earlier reports in this series.

Results Achieved

The development of the rail transportation system in the United States is reviewed in three perspectives: historical, current, and future outlook. Several recommendations are made for the improvement of the existing system, so that it can reasonably be expected to accommodate its share of the 4,100 billion ton-miles in total freight requirements projected for the 1990s by the Department of Transportation.

Data were gathered on the dependent variable (revenue freight carried by rail in Texas) for the base period 1950 to 1972. Data on twenty-nine independent variables (economic indicators of the Texas economy) were gathered for the same time period, with any missing values being estimated by the OMNITAB computer program POLYFIT. POLYFIT allows the investigator to determine what type of curve best fits the known data points.

Multiple regression analysis (SPSS, Statistical Package for the Social Sciences) was used to measure the linear relationship between the dependent variable and a set of independent variables. The equation from step ten of the SPSS subprogram REGRESSION, using the stepwise mode, was selected as the best predictor regression equation.

Forecasts for each of the ten selected variables were computed for the years 1975, 1980, 1985, and 1990 by extrapolating the chosen curve (either first degree polynomial, second degree polynomial, exponential, or Gompertz). The forecasted values were substituted into the regression equation to yield forecasts for the tons of revenue freight carried by rail in Texas for 1975, 1980. 1985, and 1990.

Utilization of Results

The results will be of interest to transportation planners for Texas, forecasters of traffic in all transportation modes, and individuals with a particular interest in rail freight traffic. The methodology employed in developing these and other forecasts in this series should be useful to anyone attempting a similar study for another region or transportation mode.

Conclusion

The ten-step equation selected as the best predictor regression equation is:

Revenue tons of freight carried by rail in Texas =
152.15082 Fabricated metal products value added by manufacture
- 0.77856 Sand and gravel production
+ 0.21297 Crude petroleum production
- 0.04337 Value of mineral production
+ 80.25791 Chemical and allied products value added by manufacture
- 373.28613 Lumber and wood products value added by manufacture
- 0.02102 Natural gas production
- 111.28568 Apparel and related products value added by manufacture
+ 173.59303 Stone, clay, and glass products value added by manufacture
- 13.96414 Resident population estimates
+ 276,742.15402

with $R^2 = 0.99362$, $\alpha_c < 0.005$, $V_{\bar{x}} = 0.0133567$, and $\alpha_{eq} < 0.001$.

The forecasts for revenue freight carried by rail in Texas were computed to be:

Year	Tons of Rail Freight
1975	237,102,040
1980	264,692,770
1985	293,405,720
1990	315,483,330

PREFACE

This report is a forecast of the demand for rail freight in Texas through 1990. Research has been accomplished under a contract with the U.S. Department of Transportation (DOT-OS-30093).

The facilities and resources of the Bureau of Business Research at The University of Texas at Austin, under the direction of Dr. Stanley A. Arbingast, Professor of Resources, were used in the preparation of this report. The research was supervised by Dr. Charles T. Clark, Associate Professor of Business Statistics at The University of Texas at Austin, with helpful suggestions from Charles P. Zlatkovich, Research Associate and Transportation Specialist at the Bureau of Business Research. Mary Gorse, Dianne Priddy, and Edward N. Kasparik, Research Associates, along with Deborah Goltra, Research Assistant, were instrumental in the preparation of this report. Florence Escott, Associate Director of the Bureau of Business Research, cooperated in many details of publication; Dr. Margaret Woodruff edited the report; Jewell Patton and Geraldine Edwards typed the report; and offset printing was the work of Robert Dorsett and Daniel Rosas, assisted by Robert Jenkins and Salvador Macias.

David L. Williams

April 1975

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIXES

*Value Added By Manufacture

CHAPTER 1

INTRODUCTION

History of Rail Transportation

Before the Revolutionary War products were transported and distributed by packhorses, wagons, stage coaches, barges, and boats. The first railroad in the United States was built in 1826, over a route of 2 3/4 miles, from granite quarries at Quincy, Massachusetts, to the Neponset River.

The first railroad built for the use of the general public was the Baltimore and Ohio, which was chartered in 1827. Three years later, in 1830, the first 13-mile section was opened to the general public. Other railroads were chartered around this time, and by 1830 there were 23 miles of rail lines in operation in the United States.[2]

The early developmental period of the railroads was stimulated by investments of capital which had previously been associated with canals and turnpikes. Where a new railroad was built, increased prosperity quickly followed. It was this profitability which prompted the building of new railroads throughout the country. New lines were constructed on the assumption that the demand would grow to meet the increased capacity, and for many years this was the case. The expansion in railroads was predominately east to west, but it was not until May 10, 1869, when the Union Pacific and the Central Pacific rails met at Promontory, Utah, that a truly transcontinental railroad was completed.

The 23 miles of rail line in 1830 grew to 3,000 miles in 1840 and to 9,000 miles in 1850. The period of rapid expansion in railroad mileage began in 1850 and by 1860 there were 30,000 miles of line in operation. By 1900 there were 193,000 miles of line and this increased to an all-time high of 254,000 miles in 1916.[3] Since that time unprofitable mileage has been abandoned at a fairly steady rate, slightly in excess of 900 miles per year, leaving an estimated 201,300 miles of line in operation in 1973.[4]

---

[1] William J. Knorst and E. Albert Ovens, *Transportation and Traffic Management*, 13th ed. (Chicago: College of Advanced Traffic, 1972), pp. 3-6.

[2] *Ibid.*, pp. 6-9.

[3] John F. Stover, *American Railroads* (Chicago: University of Chicago Press, 1961), pp. 264-269.

[4] Association of American Railroads, Economics and Finance Department, *Yearbook of Railroad Facts* (Washington: Association of American Railroads, 1974), p. 48.

Along with increased mileage, the capacity of equipment and the revenue ton-miles (the product of the weight of the lading in tons and the distance transported in miles) likewise increased. The peak of rail transportation prior to World War II was reached in 1929 and amounted to 447.3 billion revenue ton-miles. Revenue ton-miles have generally increased in recent years, with the all-time high, more than 851.6 billion revenue ton-miles, established in 1973.[5]

Present Status of Rail Transportation

The volume of intercity freight in the United States has increased significantly over the years, but relative to its competitors the railroads' significance has decreased. The total volume of intercity freight in 1929 was 454.8 billion ton-miles. At this time railroads transported 74.9 percent of the total intercity freight. The volume of intercity freight has increased to a 1973 total of 860.0 billion ton-miles; the railroads' share, however, has decreased to 38.7 percent. During the same period the proportion transported by trucks rose from 3.3 percent to 23 percent, while that by pipelines increased from 4.4 percent to 22.3 percent.[6]

According to a 1973 study, "The loss in the railroads' market share can be attributed to three basic causes: (1) the greater growth of traffic possessing characteristics for which other modes have a comparative advantage; (2) the loss of traffic to new modes having inherent cost and service advantages for the traffic; and (3) the diversion from railroads of traffic for which the rails have an inherent or latent comparative advantage that is thwarted by regulation or other impediments."[7]

The newer modes of transport (truck, pipeline, and airplane) have developed to satisfy specialized needs, resulting in the reallocation of traffic on the basis of comparative advantage. The trucking industry has flourished largely because of the Interstate Highway System and because of a general shift to high-value cargo, with emphasis on the quality of service.[8] Pipelines have likewise increased their share of the freight market as a result of their low cost per ton-mile and their increased capacity made possible by large-diameter

---

[5] *Ibid.*, p. 29.

[6] *Ibid.*, p. 36.

[7] Task Force on Railroad Productivity, *Improving Railroad Productivity* (Washington, 1973), p. 32.

[8] *Ibid.*, pp. 33-36.

pipe. Finally, airlines, with the advent of the new wide-body jumbo jets, have increased cargo capacity while decreasing costs.

The continued growth of intercity freight traffic is well established, but the composition and demands of that traffic have changed in ways which tend to be suited less and less to traditional forms of rail transportation. It is these changes in market and demands which have resulted in the railroads' loss in the freight market.

Future Outlook for Rail Transportation

The railroad industry today presents a troubled appearance. Several of the railroads in the Northeast are in bankruptcy proceedings, with several other lines throughout the United States nearing that state. According to the Task Force on Railroad Productivity, "The Penn Central is in some ways only a more extreme manifestation of trends present throughout much of the industry."[9] Problems such as inadequate earnings, unreliable service, deteriorating physical plant, and an ineffective organizational structure must be overcome before American railroads can attain the efficiency of which they are capable.

The Department of Transportation has forecast that the total freight requirements in the 1990s will be 4,100 billion ton-miles.[10] Rail transport will be responsible for moving a greater proportion of total freight traffic in the future.

Innovations such as specialized freight cars, automated classification yards, centralized traffic control, mechanized maintenance, and automation of clerical functions have had significant consequences during the postwar period. In adjusting to increased demands there are many areas of innovation that promise significant gains in railroad productivity. Containerization, piggyback, and unit-train technology may act to regain some of the freight lost to competing modes. Freight-car management systems such as TOPS, TRAINS, and TRAINS II will work to match the supply of freight cars with the demand to increase car utilization and productivity. Train scheduling will provide increased productivity and dependability through the operation of shorter trains and more frequent schedules. Instituting the procedures of modern managerial accounting will result in improved costing, pricing, and profit

---

[9] Ibid., p. 322.

[10] Association of American Railroads, op.cit., p. 7.

analysis. Stimulation of and planning for new markets for railroad service is an additional area of recommended innovation.[11]

Railroad research is progressing rapidly toward cost-effective responses to many of the problems which have plagued the industry. Although budget allocations for railroad research are low in comparison with those in other industries, the federal government has increased its involvement through the Federal Railroad Administration.[12] Current research programs include tank car safety, locomotive cab safety, terminal problems, coupler safety, environmental matters, and possibly the most promising, traintrack dynamics.[13]

One major factor which may tend to increase reliance on railroads is the energy efficiency inherent in railroad operation as compared with competing modes of transportation. A study done by Missouri Pacific's Traffic Research Division established the energy requirements of railroads as follows: railroads required 536 to 791 BTU per net ton-mile as compared with 2,518 to 2,800 BTU per net ton-mile for motor carriers. Other forms of transport require even more fuel, the least efficient mode being helicopters, which consume 187,000 BTU per net ton-mile. Railroads perform more work for the amount of energy consumed than do most competing transportation modes.[14]

Railroads are concerned with other environmental considerations in addition to the conservation of energy. Even though less than ½ percent of all smoke produced by business was caused by locomotive diesel engines, the railroads expended $2.7 billion in 1972 for the control of smoke and emissions. Railroads are also attempting to discover ways of preventing dust from blowing out of open freight cars. Other environmental programs currently being undertaken by railroads include clearing rights-of-way of litter and disposing of used materials such as crossties, old freight cars, and dirty lubricants which have been used in locomotives.[15]

Perhaps the major obstacle to be overcome by the railroads in the future is that of deferred maintenance. Since the switch in the 1950s from steam to diesel locomotives, accidents involving the resulting longer and faster trains

---

[11] Task Force on Railroad Productivity, *op.cit.*, pp. 282-314.

[12] *Ibid.*, pp. 314-318.

[13] Association of American Railroads, *op.cit.*, p. 8.

[14] Gus Welty and Robert D. Bartley, "Guardians of the Environment, Conservers of Energy," *Railway Age*, 10 December 1973, pp. 34-36.

[15] *Ibid.*

have increased in alarming numbers, due largely to the deteriorating and unsafe track conditions. Only recently have railroads begun admitting the consequences of deferred maintenance. The cost of replacing worn-out rail and ties alone is estimated at $5.8 billion for the entire industry. The extent of deferred maintenance is relatively great for the Penn Central; the Chicago, Rock Island and Pacific; the Missouri-Kansas-Texas; the Kansas City Southern; the Reading; and the Lehigh Valley, as opposed to such systems as the Santa Fe, the Union Pacific, and the Chessie, which have little or no deferred maintenance.[16]

A workable solution to the problem of deferred maintenance has not yet been discovered. Railroads often hold that it is not their responsibility to maintain track on which they operate at a loss. In efforts to improve poor trackage, shippers have individually or in groups offered funds as interest-free loans or as outright gifts to railroads to effect the repair of bad track. Such states as New York and New Jersey have provided funds specifically for deferred maintenance and the United States Congress is considering various alternatives.[17] Whatever an acceptable solution may be, it is certain that before United States railroads can perform to capacity, this problem of deferred maintenance, along with others, must be solved.

---

[16] Lewis A. Phelps, "As Railroads Defer More Maintenance, Number of Accidents Increases Sharply," The Wall Street Journal, 10 October 1974, p. 34; Gail Bronson, "More Disgruntled Shippers Underwrite Routine Railroad Maintenance Inspection," The Wall Street Journal, 16 October 1974, p. 40; Bill Paul, "Federal Effort to Reduce Rail Accidents is a Bust; Many Factors Share the Blame," The Wall Street Journal, 21 October 1974, p. 22.

[17] Gail Bronson, op.cit.; Bill Paul, op,cit.

CHAPTER 2

ANALYSIS

Estimation of Missing Values

In most cases the data from 1950 to 1972 were available. However, for the small number of variables with missing values, estimations were made to be used in the analysis. The estimation for a missing value was made by either a first degree, a second degree, or a third degree polynomial equation obtained from the OMNITAB computer program POLYFIT. The equation with the lowest residual standard deviation not producing a negative number was generally selected as the estimator.

Multiple Regression Analysis

According to Clark and Schkade, "regression analysis is concerned with the derivation of a mathematical model with which to relate quantitatively the variation of a dependent variable with the variations of one or more independent variables."[18] The model equation takes the form:

$$Y_c = A + B_1X_1 + B_2X_2 + B_3X_3 + \cdot \cdot \cdot + B_nX_n$$

where the X's are specific independent variables, the B's are regression coefficients, A is a constant, and Y_c is the predicted value of the dependent variable.

The computer program SPSS (Statistical Package for the Social Sciences) using the stepwise mode of the subprogram REGRESSION was used to analyze the data. This program first picks the independent variable which best correlates with the dependent variable and then proceeds to pick variables, one at a time, which provide the best prediction in conjunction with the variables already in the equation.

The SPSS stepwise multiple regression program makes available a series of regression equations, one for each step for which the program is able to enter another variable before it reaches certain preset cutoff values. The equation that has the highest R^2 (coefficient of determination), the lowest α level for the significance of the coefficients, the lowest coefficient of variability, and the lowest α level for the significance of the regression equation, or the optimal combination of these factors, is picked as the predictor regression equation.

---

[18] Charles T. Clark and Lawrence L. Schkade, Statistical Analysis for Administrative Decisions, 2nd ed. (Cincinnati: South-Western Publishing Co., 1974), p. 605.

Independent Variables Forecast

Variables included in the chosen predictor equation were run on the STATPAK, TREN, OMNITAB, and POLYFIT computer programs to fit the base period data, 1950 to 1972, to first degree and second degree polynomials, an exponential curve, and a Gompertz curve (if possible). Extrapolations of these variables for each curve were then computed for the years 1975, 1980, 1985, and 1990.

The standard error of estimate was computed for each variable and for each of its curves. The curve yielding the best fit as judged by the standard error was generally chosen in each case to be used in the regression equation.

Dependent Variable Forecast

The forecasted values for each selected independent variable for the year 1975 were substituted into the regression equation to yield a forecast for the 1975 tons of revenue freight transported by rail in Texas. This procedure was then followed for the years 1980, 1985, and 1990.

CHAPTER 3

DATA

Dependent Variable

The data for the dependent variable, tons of revenue freight carried by rail, were found in various editions of the *Annual Report of the Railroad Commission of Texas* for the years 1952 to 1972. Data for the years 1950 and 1951 were found in the 1954-1955 edition of the *Texas Almanac*. All railroad companies in the state of Texas were included in the variable, tons of revenue freight carried by rail. Some ambiguity may result, however, from the practice of recording a shipment whenever the lading is exchanged between carriers. The base period data for revenue freight carried by rail in Texas is presented in Figure 1 and Table 1.

Independent Variables

Twenty-nine independent variables were included in this research project. The variables and their computer titles are listed in Table 2. These variables will be referred to by their computer titles.

The variables APPAREL, CHEMICAL, ELECMACH, FABMETAL, FOOD, LUMBER, METALS, NONELECM, PAPER, PETRCOAL, STCLGLAS, TOTALVAM, and TRANSEQP were all found in two publications: *Annual Survey of Manufactures*, by the U.S. Department of Commerce, Bureau of the Census, for the years 1950 to 1953, 1955 to 1957, 1959 to 1962, 1964 to 1966, and 1968 to 1971; and the *Census of Manufactures, Volume III, Area Statistics*, by the U.S. Department of Commerce, Bureau of the Census, for the years 1954, 1958, 1963, 1967, and 1972 (Preliminary Report).

The variables CRUDEPET, MINERAL, NATGAS, NATGASLQ, and SANDVEL were all found in the *Minerals Yearbook*, by the U.S. Department of the Interior, Bureau of Mines, for the years 1950 to 1971. Data for 1972 were found in the *Mineral Industry Surveys, Annual, Preliminary*, by the U.S. Department of the Interior, Bureau of Mines.

The variables AUTOREG, BUSREG, TRUCKREG, and VEHICLES were all found in *Highway Statistics, Summary to 1965* by the U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, for the years 1950 to 1965. Data for the years 1966 to 1972 were found in *Highway Statistics*, by the U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads.

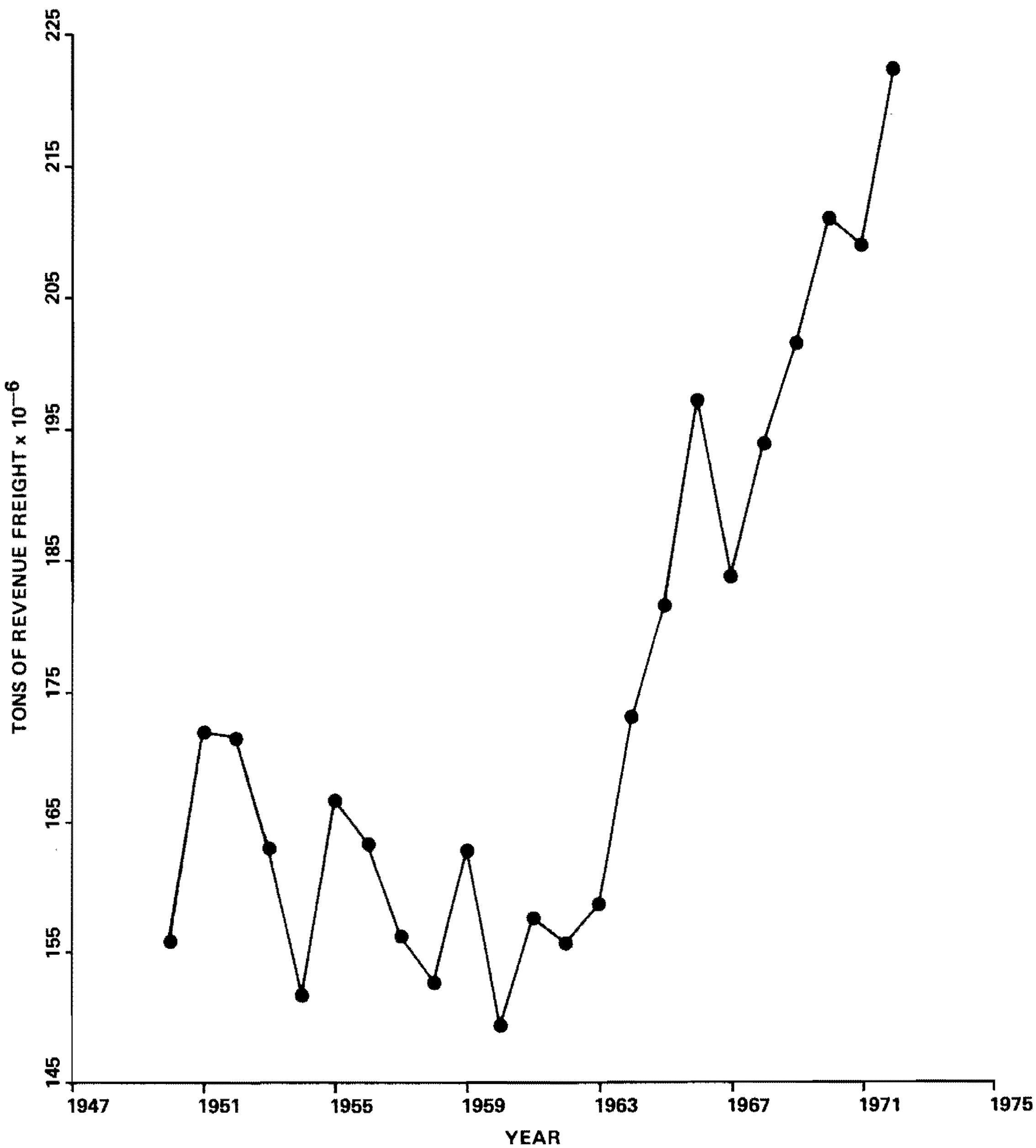

FIGURE 1. RAIL TONS OF REVENUE FREIGHT IN TEXAS

TABLE 1. REVENUE FREIGHT CARRIED BY RAIL IN TEXAS

Year	Tons	Year	Tons
1950	155,970,914	1962	155,728,821
1951	171,974,878	1963	158,750,736
1952	171,536,799	1964	173,074,704
1953	163,120,463	1965	181,553,163
1954	151,639,475	1966	197,208,761
1955	166,742,660	1967	183,742,685
1956	163,448,004	1968	193,822,546
1957	156,218,472	1969	201,455,133
1958	152,687,265	1970	211,069,076
1959	162,985,269	1971	208,878,010
1960	149,360,161	1972	222,303,703
1961	157,700,142		

Source: Railroad Commission of Texas, Annual Report of the Railroad Commission of Texas (Austin: Railroad Commission of Texas, 1951-73 editions).

TABLE 2. COMPLETE TITLES AND COMPUTER TITLES OF VARIABLES

Complete titles	Computer titles
Dependent Variable:	
Tons of revenue freight carried by rail	RAILCAR
Independent Variables:	
Apparel and related products*	APPAREL
Automobile registrations	AUTOREG
Bus registrations	BUSREG
Cash receipts from farm marketings	FARMREC
Chemical and allied products*	CHEMICAL
Crude oil and products pipeline mileage	PIPELINE
Crude petroleum production	CRUDEPET
Electrical machinery*	ELECMACH
Employees on nonagricultural payrolls	NONAGEMP
Employment in manufacturing industries	MFGEMP
Fabricated metal products*	FABMETAL
Food and kindred products*	FOOD
Lumber and wood products*	LUMBER
Motor vehicle registrations	VEHICLES
Natural gas liquids production	NATGASLQ
Natural gas production	NATGAS
Nonelectric machinery*	NONELECM
Paper and allied products*	PAPER
Petroleum and coal products*	PETRCOAL
Primary metals*	METALS
Resident population estimates	POPULATN
Sand and gravel production	SANDVEL
Stone, clay, and glass products*	STCLGLAS
Total gasoline consumption	GASOLINE
Total personal income	INCOME
Total value added by manufacture	TOTALVAM
Transportation equipment*	TRANSEQP
Truck registrations	TRUCKREG
Value of mineral production	MINERAL

*Value added by manufacture.

The remaining variables came from different sources. The variable GASOLINE was found in _Petroleum Facts and Figures_, by the American Petroleum Institute, Division of Statistics, for all years. INCOME was taken from the _Survey of Current Business_, by the U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, for all years. The variable POPULATN was found in _Current Population Reports_, Series P-25, by the U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, for all years. The variable MFGEMP was taken from an unpublished "Report of Employment," submitted to the U.S. Department of Labor, Bureau of Labor Statistics, Division of Manpower and Employment Statistics, for all years. NONAGEMP was found in _Employment and Earnings, States and Areas 1939-1972_, Bulletin 1370-10, by the U.S. Department of Labor, Bureau of Labor Statistics, for all years. The variable FARMREC was taken from _Farm Income Situation Supplement, Farm Income, State Estimates_, by the U.S. Department of Agriculture, Economic Research Service, for all years. The final variable, PIPELINE, was found in _Transport Statistics in the United States, Part 6, Oil Pipe Lines_, by the U.S. Interstate Commerce Commission, Bureau of Accounts, for all years.

CHAPTER 4

RESULTS

Regression Equation

The predictor regression equation chosen from the SPSS computer program was from step ten. The equation is:

$$\begin{aligned} \text{RAILCAR} = {} & 152.15082\ \text{FABMETAL} - 0.77856\ \text{SANDVEL} \\ & + 0.21297\ \text{CRUDEPET} - 0.04337\ \text{MINERAL} \\ & + 80.25791\ \text{CHEMICAL} - 373.28613\ \text{LUMBER} \\ & - 0.02102\ \text{NATGAS} - 111.28568\ \text{APPAREL} \\ & + 173.59303\ \text{STCLGLAS} - 13.96414\ \text{POPULATN} \\ & + 276742.15402 \end{aligned}$$

with a coefficient of determination of 0.99362, a coefficient of variability of 1.33567 percent, and a significance level of 0.005. Table 3 is a reproduction of step ten of the SPSS program.

Independent Variables Forecast

The base period data for the ten chosen variables are presented in Appendix A. These independent variables in the regression equation were each fitted with a first degree polynomial, a second degree polynomial, an exponential curve, and a Gompertz curve (if possible). Extrapolations of the variables are graphed in Appendix B. Generally, the curve with the smallest standard deviation was chosen as the forecast for that variable. Table 4 contains the forecasted values for the ten independent variables for the years 1975, 1980, 1985, and 1990.

Dependent Variable Forecast

The forecasted values for each independent variable were substituted into the regression equation at the appropriate times to produce forecasts for the total tons of revenue freight carried by Texas railroads for the years 1975, 1980, 1985, and 1990. These regression forecasts are presented in Table 5 and Figure 2. Figure 2 also includes the base period data and first degree polynomial, second degree polynomial, and exponential extrapolations of revenue tons of freight carried by rail in Texas, for comparative purposes.

TABLE 3. STEP TEN OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM

DEPENDENT VARIABLE.. RAILCAR TOTAL TONS OF REVENUE FREIGHT CARRIED

VARIABLE(S) ENTERED ON STEP NUMBER 10.. POPULATN RESIDENT POPULATION ESTIMATES

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
MULTIPLE R	,99681					
R SQUARE	,99362	REGRESSION	10	10141935509,02161	1014193550,90216	186,93125
STD DEVIATION	2329,26801	RESIDUAL	12	65105873,82596	5425489,48550	

MEAN RESPONSE 174390,07883
COEFFICIENT OF VARIABILITY 1,33567 PERCENT

---------------------- VARIABLES IN THE EQUATION ----------------------

VARIABLE	B	BETA	STD ERROR B	F
FABMETAL	152,15082	2,12830	21,42555	50,42949
ELASTICITY	,32539			
SANDVEL	-,77856	-,20868	,23979	10,54221
ELASTICITY	-,12625			
CRUDEPET	,21297	1,12369	,01992	114,28849
ELASTICITY	1,27526			
MINERAL	-,04337	-2,27307	,00491	78,01352
ELASTICITY	-1,14810			
CHEMICAL	80,25791	2,90820	8,34000	92,60689
ELASTICITY	,71635			
LUMBER	-373,28613	-1,04193	60,34272	38,26784
ELASTICITY	-,25322			
NATGAS	-,02102	-1,51779	,00598	12,35078
ELASTICITY	-,72364			
APPAREL	-111,28568	-,73434	37,73767	8,69618
ELASTICITY	-,14416			
STCLGLAS	173,59303	1,19262	58,87910	8,69245
ELASTICITY	,27016			
POPULATN	-13,96414	-,74326	5,55209	6,32579
ELASTICITY	-,77870			
(CONSTANT)	276742,15402			

----------- VARIABLES NOT IN THE EQUATION -----------

VARIABLE	PARTIAL	TOLERANCE	F
GASOLINE	,04658	,16844	,02392
INCOME	,28791	,00296	,99423
VEHICLES	,37096	,00254	1,75529
MFGEMP	,14621	,02525	,24029
NONAGEMP	,19490	,00642	,43436
TOTALVAM	,28499	,00568	,97239
FARMREC	-,15850	,03838	,28345
TRANSEQP	,15271	,07424	,26266
NONELECM	,21596	,01328	,53813
FOOD	-,10645	,00172	,12608
METALS	,31233	,02044	1,18901
PAPER	,19454	,01208	,43269
PETRCOAL	,29545	,05799	1,05199
TRUCKREG	,41859	,00284	2,33684
PIPELINE	1,00000	1,00000	0,00000
NATGASLW	,32684	,00884	1,31565
ELECMACH	,35700	,00871	1,60671
AUTOREG	,32747	,00285	1,32134
BUSREG	-,00995	,14448	,00109

TABLE 4. FORECASTS FOR THE INDEPENDENT VARIABLES IN THE REGRESSION EQUATION

Independent Variable	Year				Type of Curve
	1975	1980	1985	1990	
FABMETAL	1,335.82	1,963.24	2,718.72	3,602.25	Second degree
SANDVEL	36,707.2	39,717.1	42,726.9	45,736.7	First degree
CRUDEPET	1,204,960	1,270,660	1,339,940	1,413,000	Exponential
MINERAL	7,163,910	8,463,860	9,999,690	11,814,200	Exponential
CHEMICAL	3,134.21	3,697.66	4,261.11	4,824.57	First degree
LUMBER	206.892	260.339	327.592	412.219	Exponential
NATGAS	9,563,980	11,189,300	12,998,800	14,999,400	Gompertz
APPAREL	675.270	961.824	1,305.31	1,705.73	Second degree
STCLGLAS	613.153	766.355	933.622	1,114.96	Second degree
POPULATN	11,801.7	12,339.4	12,795.8	13,180.4	Gompertz

TABLE 5. FORECAST OF REVENUE FREIGHT CARRIED BY RAIL IN TEXAS

Year	Tons
1975	237,102,040
1980	264,692,770
1985	293,405,720
1990	315,483,330

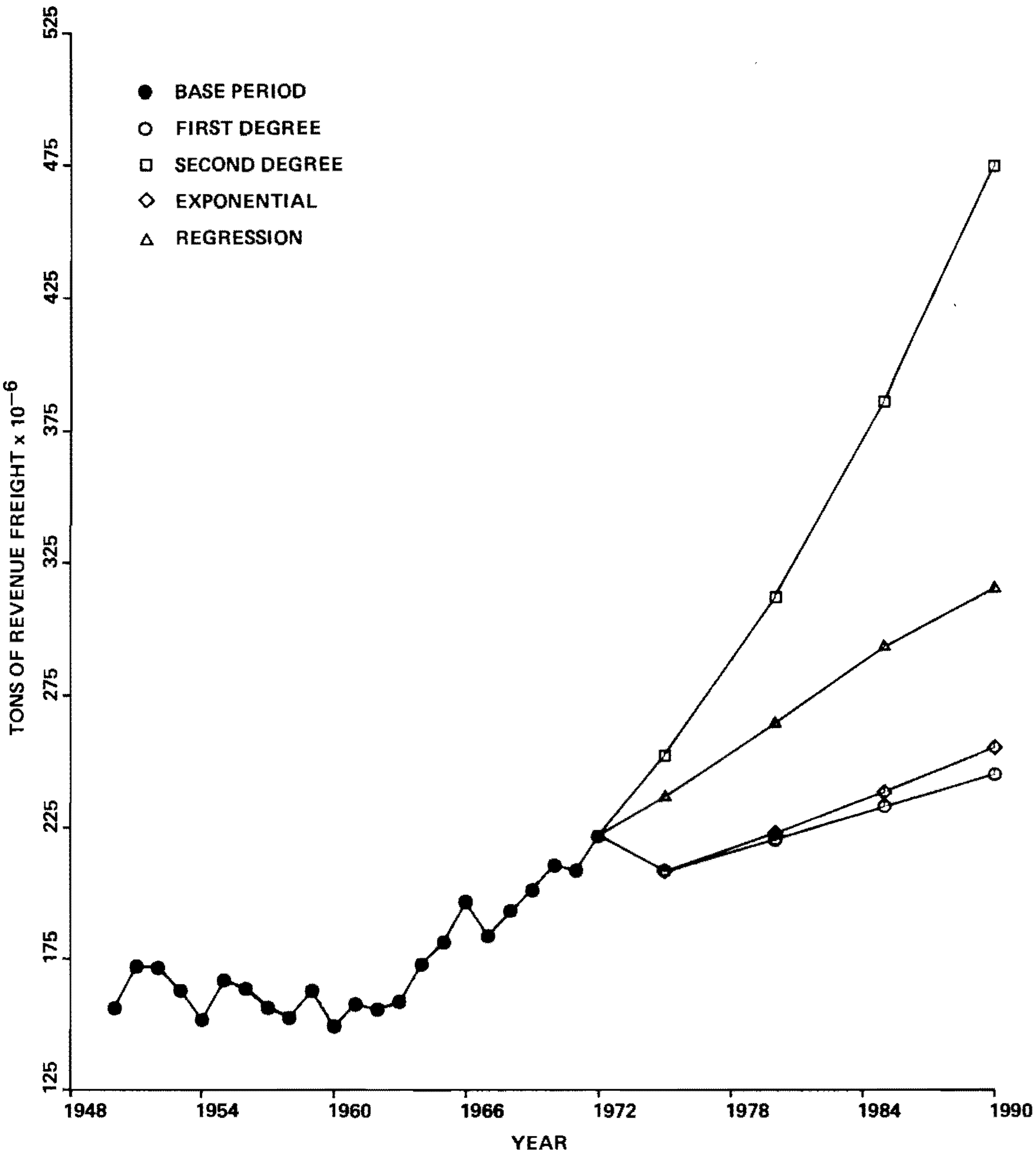

FIGURE 2. COMPARISON OF RAIL TONS OF REVENUE FREIGHT FORECAST AND EXTRAPOLATIONS

APPENDIX A

TABLE A-1. APPAREL AND RELATED PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS

Year	Millions of Dollars	Year	Millions of Dollars
1950*	75.8	1962	179.2
1951*	82.9	1963	223.8
1952*	89.6	1964	245.3
1953	103.2	1965	242.8
1954	98.7	1966	285.5
1955	99.8	1967	344.7
1956	114.3	1968	362.9
1957	131.3	1969	399.7
1958	140.0	1970	435.4
1959	159.4	1971	498.2
1960	168.6	1972	553.8
1961	161.0		

*OMNITAB third degree equation estimate.

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1954, 1958, 1963, 1967, and 1972-preliminary editions).

TABLE A-2. CHEMICAL AND ALLIED PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS

Year	Millions of Dollars	Year	Millions of Dollars
1950	477.5	1962	1,437.8
1951	603.7	1963	1,644.7
1952	691.8	1964	1,809.9
1953	777.1	1965	1,989.2
1954	722.1	1966	2,156.1
1955	965.7	1967	2,076.7
1956	958.0	1968	2,246.0
1957	1,044.8	1969	2,516.9
1958	1,054.8	1970	2,551.2
1959	1,271.3	1971	2,886.2
1960	1,343.3	1972	3,237.2
1961	1,338.5		

Sources: U.S. Department of Commerce, Bureau of the Census, *Annual Survey of Manufactures* (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of Commerce, Bureau of the Census, *Census of Manufactures, volume III, Area Statistics* (Washington: Government Printing Office, 1954, 1958, 1963, 1967, and 1972-preliminary editions).

TABLE A-3. CRUDE PETROLEUM PRODUCTION IN TEXAS

Year	Thousands of 42-gallon Barrels	Year	Thousands of 42-gallon Barrels
1950	829,874	1962	943,328
1951	1,010,270	1963	977,835
1952	1,022,139	1964	989,525
1953	1,019,164	1965	1,000,749
1954	974,275	1966	1,057,706
1955	1,053,297	1967	1,119,962
1956	1,107,808	1968	1,133,380
1957	1,073,867	1969	1,151,775
1958	940,166	1970	1,249,697
1959	971,978	1971	1,222,926
1960	927,479	1972	1,301,685
1961	939,191		

Sources: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys, preliminary 1972 (Washington: Government Printing Office, 1973).

TABLE A-4. FABRICATED METAL PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS

Year	Millions of Dollars	Year	Millions of Dollars
1950*	22.7	1962	269.2
1951	96.1	1963	308.6
1952	89.5	1964	353.5
1953	106.8	1965	421.1
1954	131.5	1966	487.2
1955	135.3	1967	571.9
1956	145.9	1968	621.7
1957	173.7	1969	678.3
1958	239.0	1970	833.2
1959	262.1	1971	938.0
1960	256.6	1972	1,166.5
1961	269.5		

*OMNITAB third degree equation estimate.

Sources: U.S. Department of Commerce, Bureau of the Census, _Annual Survey of Manufactures_ (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of Commerce, Bureau of the Census, _Census of Manufactures, volume III, Area Statistics_ (Washington: Government Printing Office, 1954, 1958, 1963, 1967, and 1972-preliminary editions).

TABLE A-5. LUMBER AND WOOD PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS

Year	Millions of Dollars	Year	Millions of Dollars
1950	92.8	1962	81.3
1951	91.6	1963	108.8
1952	84.9	1964	115.8
1953	94.2	1965	125.1
1954	76.4	1966	125.1
1955	85.0	1967	145.8
1956	81.9	1968	144.3
1957	69.1	1969	176.2
1958	78.6	1970	159.8
1959	87.3	1971	197.1
1960	79.8	1972	341.8
1961	78.2		

Sources: U.S. Department of Commerce, Bureau of the Census, _Annual Survey of Manufactures_ (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of Commerce, Bureau of the Census, _Census of Manufactures_, _volume III_, _Area Statistics_ (Washington: Government Printing Office, 1954, 1958, 1963, 1967, and 1972-preliminary editions).

TABLE A-6. NATURAL GAS PRODUCTION IN TEXAS

Year	Millions of Cubic Feet	Year	Millions of Cubic Feet
1950	3,126,402	1962	6,080,210
1951	3,781,136	1963	6,205,034
1952	4,147,805	1964	6,490,202
1953	4,383,158	1965	6,636,555
1954	4,551,232	1966	6,953,790
1955	4,730,798	1967	7,188,900
1956	4,999,889	1968	7,495,414
1957	5,156,215	1969	7,853,199
1958	5,178,073	1970	8,357,716
1959	5,718,993	1971	8,550,705
1960	5,892,704	1972	8,657,840
1961	5,963,605		

Sources: U.S. Department of the Interior, Bureau of Mines, _Minerals Yearbook, volume III, Area Reports_ (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of the Interior, Bureau of Mines, _Mineral Industry Surveys_, preliminary 1972 (Washington: Government Printing Office, 1973).

TABLE A-7. RESIDENT POPULATION ESTIMATES IN TEXAS

Year	Thousands of Persons	Year	Thousands of Persons
1950	7,776	1962	10,053
1951	8,111	1963	10,159
1952	8,314	1964	10,270
1953	8,336	1965	10,378
1954	8,382	1966	10,492
1955	8,660	1967	10,599
1956	8,830	1968	10,819
1957	9,070	1969	11,045
1958	9,252	1970	11,197
1959	9,405	1971	11,428
1960	9,624	1972	11,649
1961	9,820		

Source: U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, Current Population Reports, Series P-25, "Population Estimates and Projections" (Washington: Government Printing Office, number 304 - April 1965, number 460 - June 1971, number 488 - September 1972, and number 508 - November 1973).

TABLE A-8. SAND AND GRAVEL PRODUCTION IN TEXAS

Year	Thousand Short Tons	Year	Thousand Short Tons
1950	17,972	1962	30,076
1951	18,488	1963	33,256
1952	18,661	1964	29,155
1953	15,101	1965	32,649
1954	26,316	1966	26,222
1955	31,518	1967	31,398
1956	29,336	1968	31,843
1957	23,685	1969	29,972
1958	32,871	1970	31,438
1959	35,295	1971	32,788
1960	29,844	1972	35,151
1961	27,398		

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys, preliminary 1972 (Washington: Government Printing Office, 1973).

TABLE A-9. STONE, CLAY, AND GLASS PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS

Year	Millions of Dollars	Year	Millions of Dollars
1950*	36.5	1962	278.2
1951*	57.8	1963	306.0
1952*	79.2	1964	325.9
1953	99.7	1965	317.1
1954	133.8	1966	333.1
1955	163.5	1967	366.4
1956	176.2	1968	393.1
1957	162.7	1969	441.0
1958	236.3	1970	450.6
1959	269.3	1971	503.8
1960	240.3	1972	606.1
1961	265.5		

*OMNITAB first degree equation estimate.

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1954, 1958, 1963, 1967, and 1972-preliminary editions).

TABLE A-10. VALUE OF MINERAL PRODUCTION IN TEXAS

Year	Thousands of Dollars	Year	Thousands of Dollars
1950	2,673,950	1962	4,323,557
1951	3,268,555	1963	4,427,474
1952	3,379,813	1964	4,533,078
1953	3,647,913	1965	4,718,826
1954	3,730,705	1966	5,022,041
1955	3,993,310	1967	5,406,371
1956	4,241,258	1968	5,505,831
1957	4,484,538	1969	5,769,970
1958	4,033,311	1970	6,401,999
1959	4,219,757	1971	6,807,955
1960	4,134,901	1972	7,211,551
1961	4,237,958		

Sources: U.S. Department of the Interior, Bureau of Mines, _Minerals Yearbook, volume III, Area Reports_ (Washington: Government Printing Office, 1950-71 editions).

U.S. Department of the Interior, Bureau of Mines, _Mineral Industry Surveys_, preliminary 1972 (Washington: Government Printing Office, 1973).

APPENDIX B

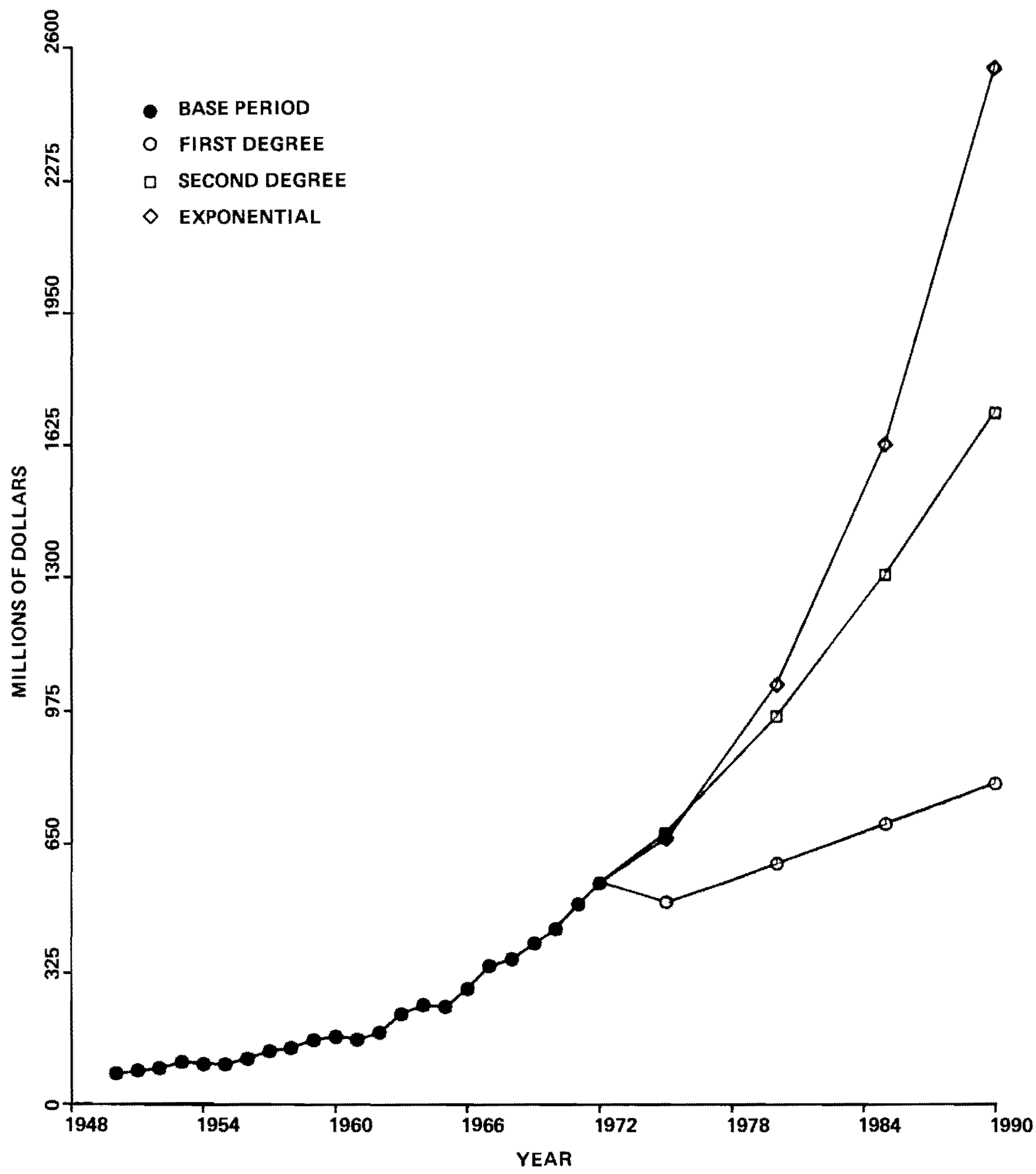

FIGURE B-1. APPAREL AND RELATED PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS EXTRAPOLATIONS

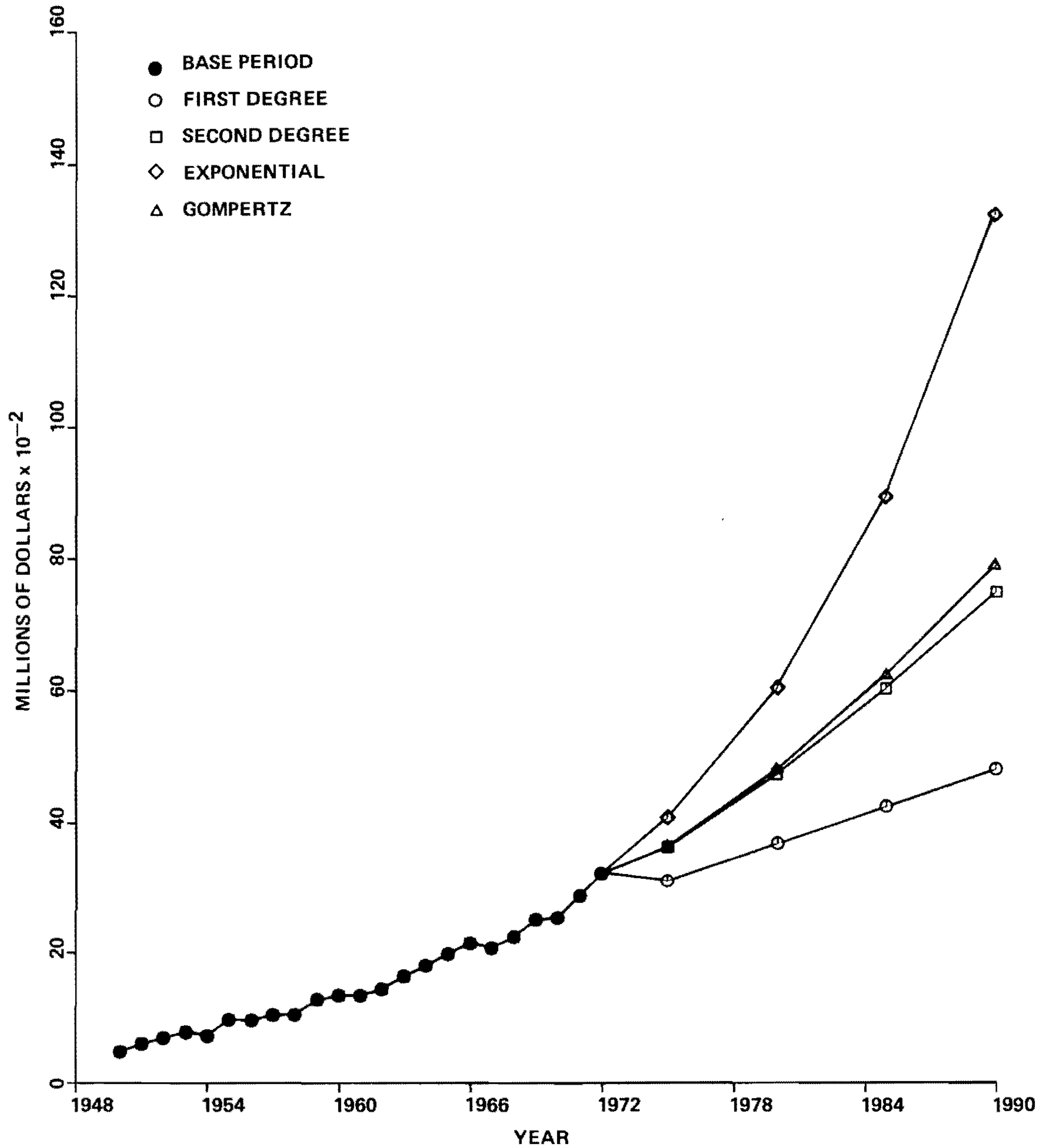

FIGURE B-2. CHEMICAL AND ALLIED PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS EXTRAPOLATIONS

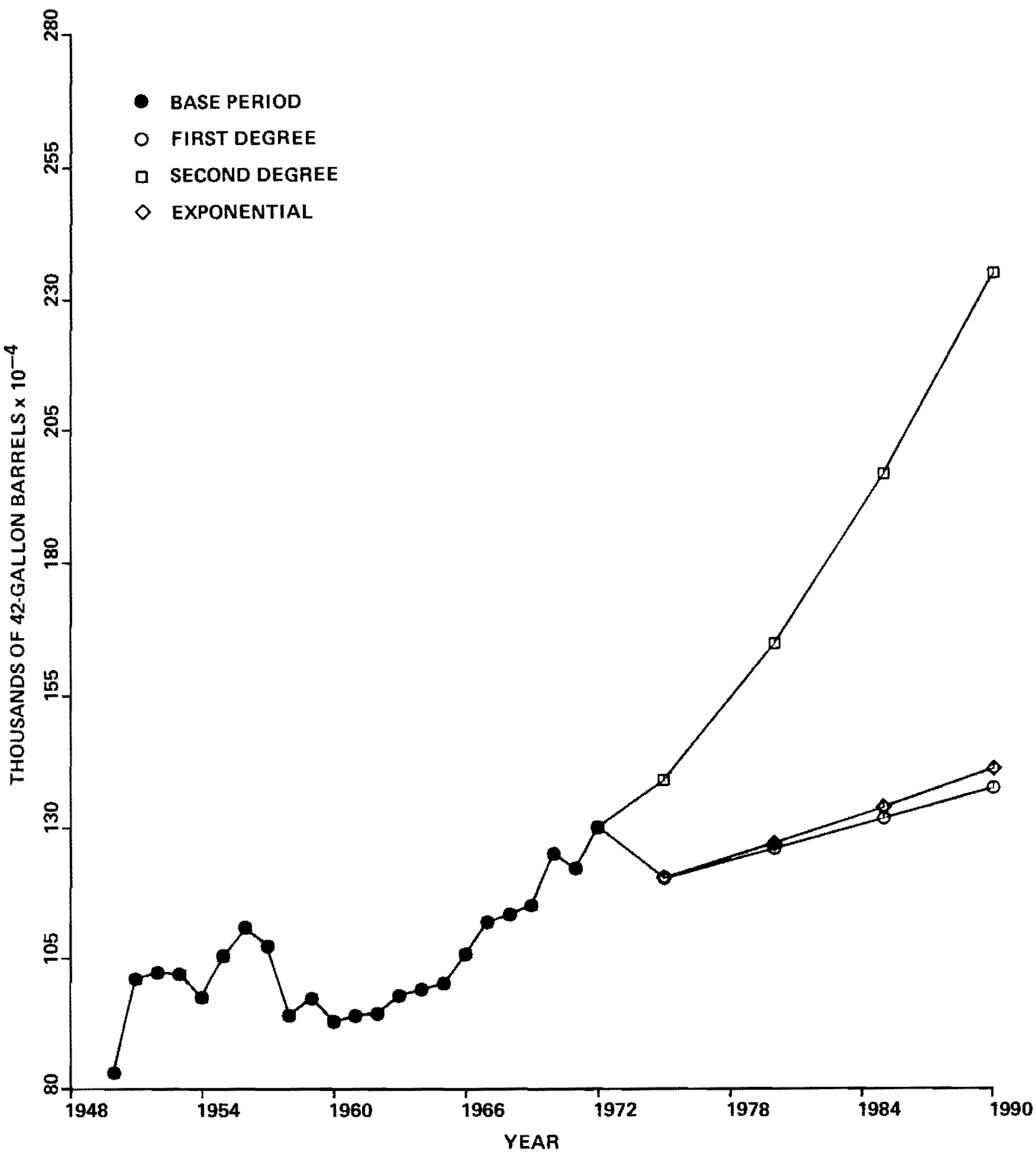

FIGURE B-3. CRUDE PETROLEUM PRODUCTION IN TEXAS EXTRAPOLATIONS

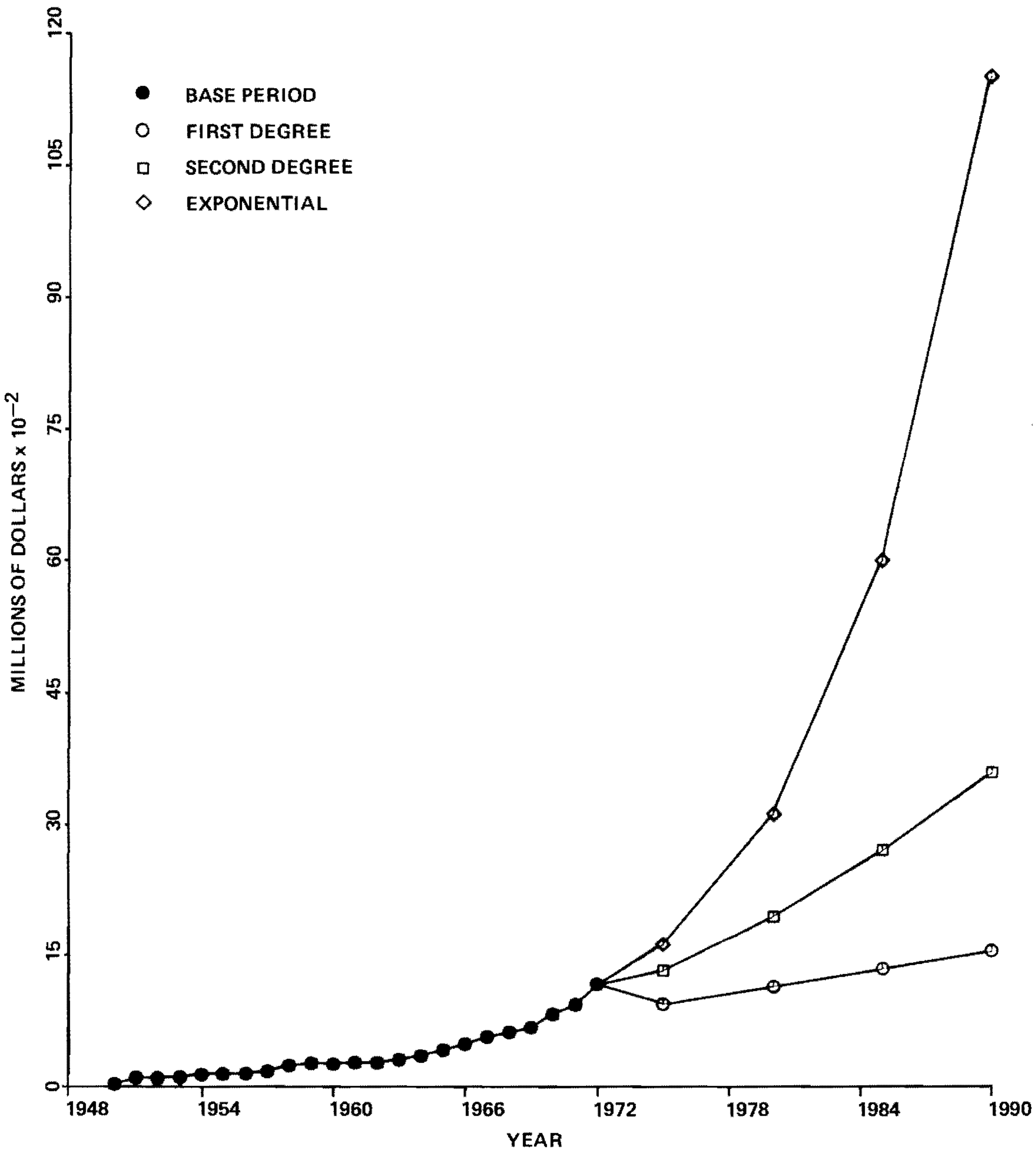

FIGURE B-4. FABRICATED METAL PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS EXTRAPOLATIONS

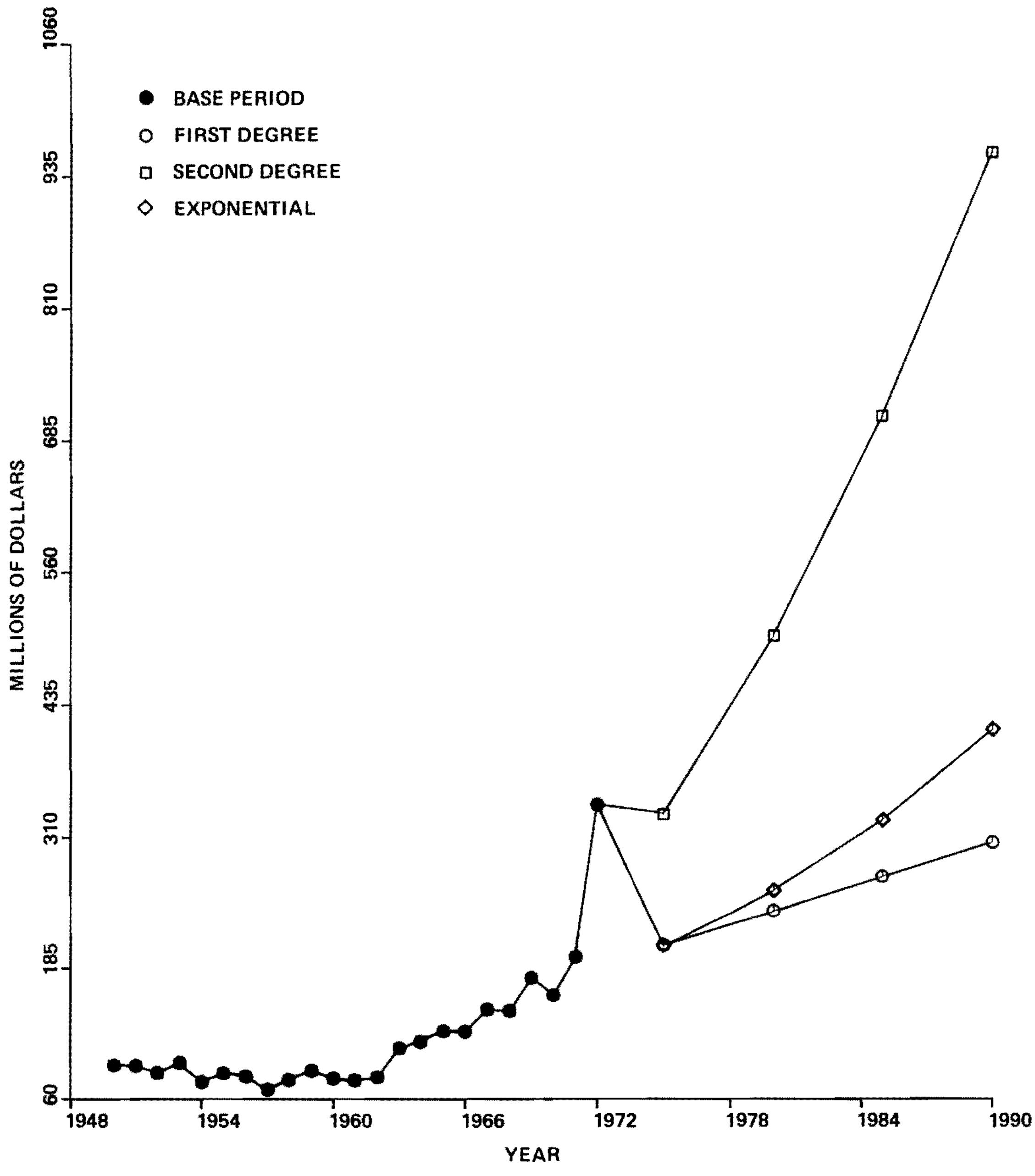

FIGURE B-5. LUMBER AND WOOD PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS EXTRAPOLATIONS

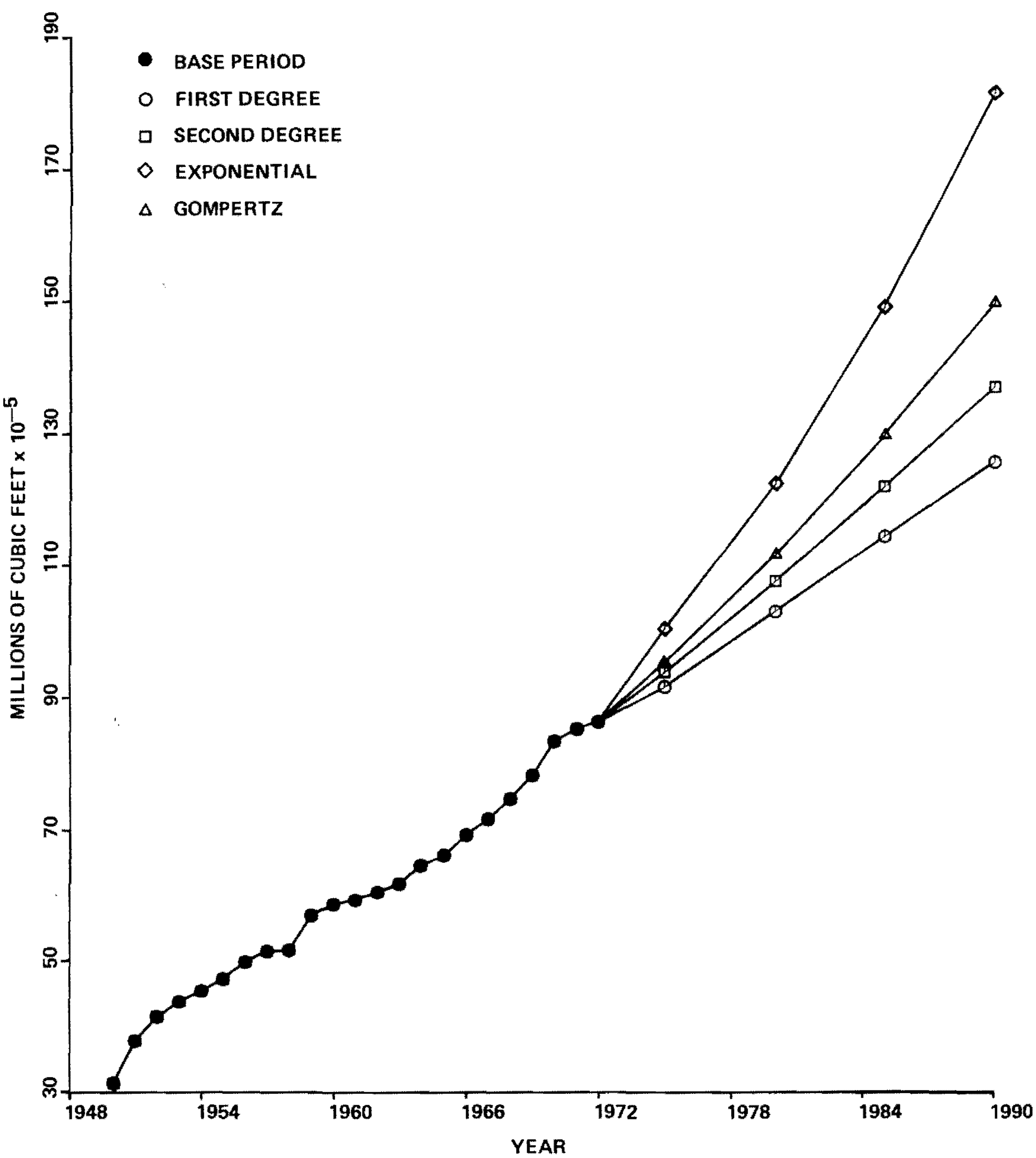

FIGURE B-6. NATURAL GAS PRODUCTION IN TEXAS EXTRAPOLATIONS

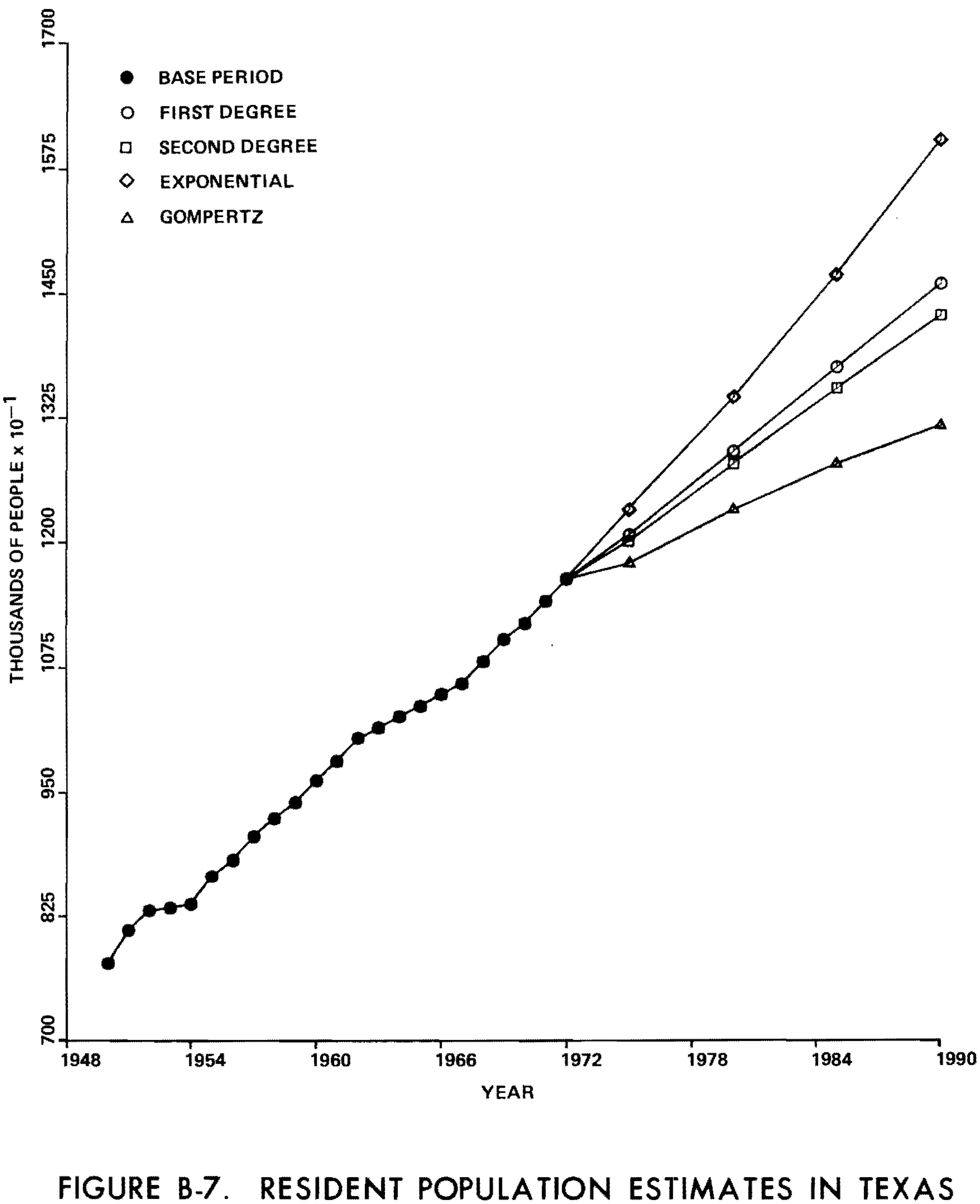

FIGURE B-7. RESIDENT POPULATION ESTIMATES IN TEXAS EXTRAPOLATIONS

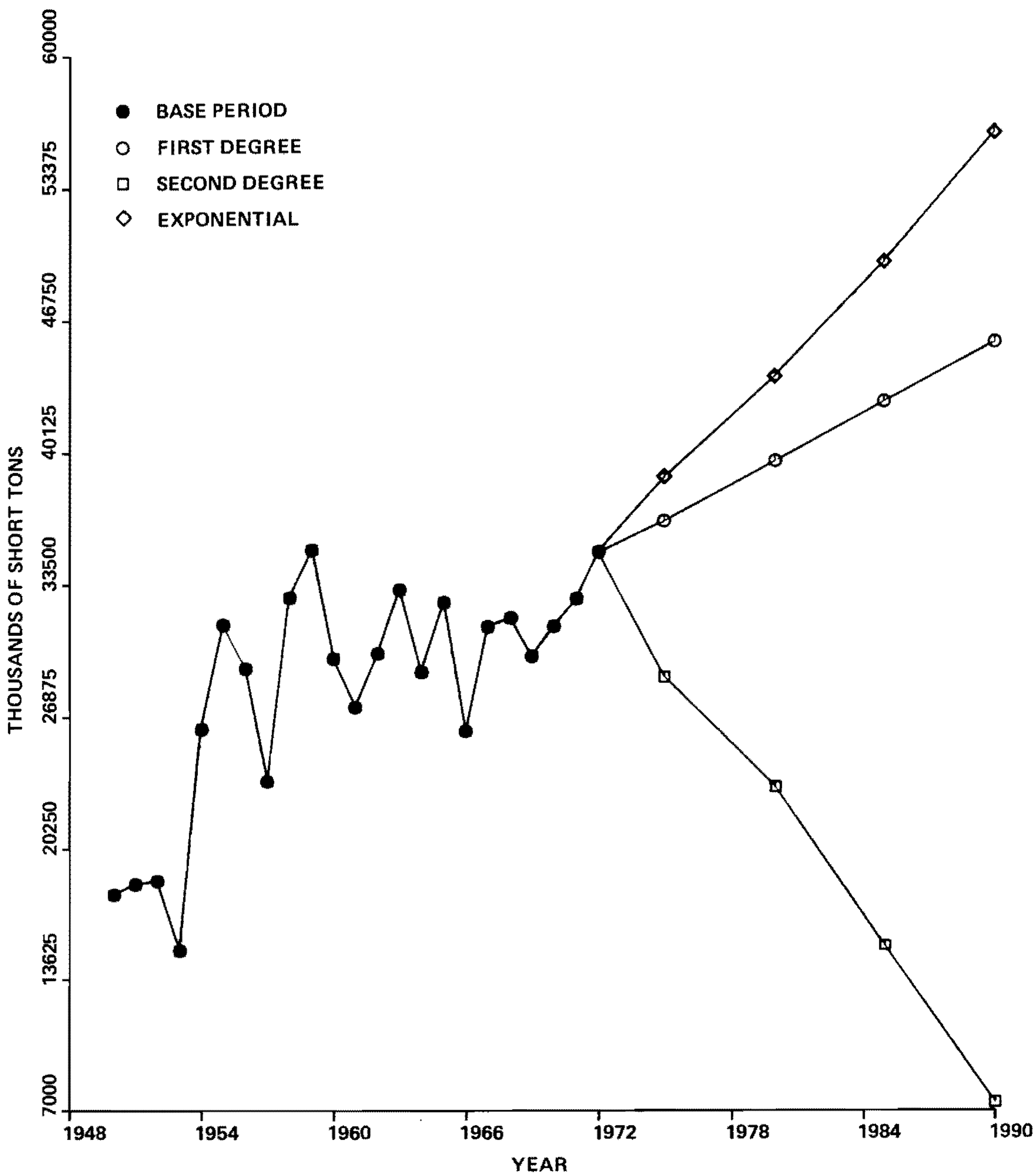

FIGURE B-8. SAND AND GRAVEL PRODUCTION IN TEXAS EXTRAPOLATIONS

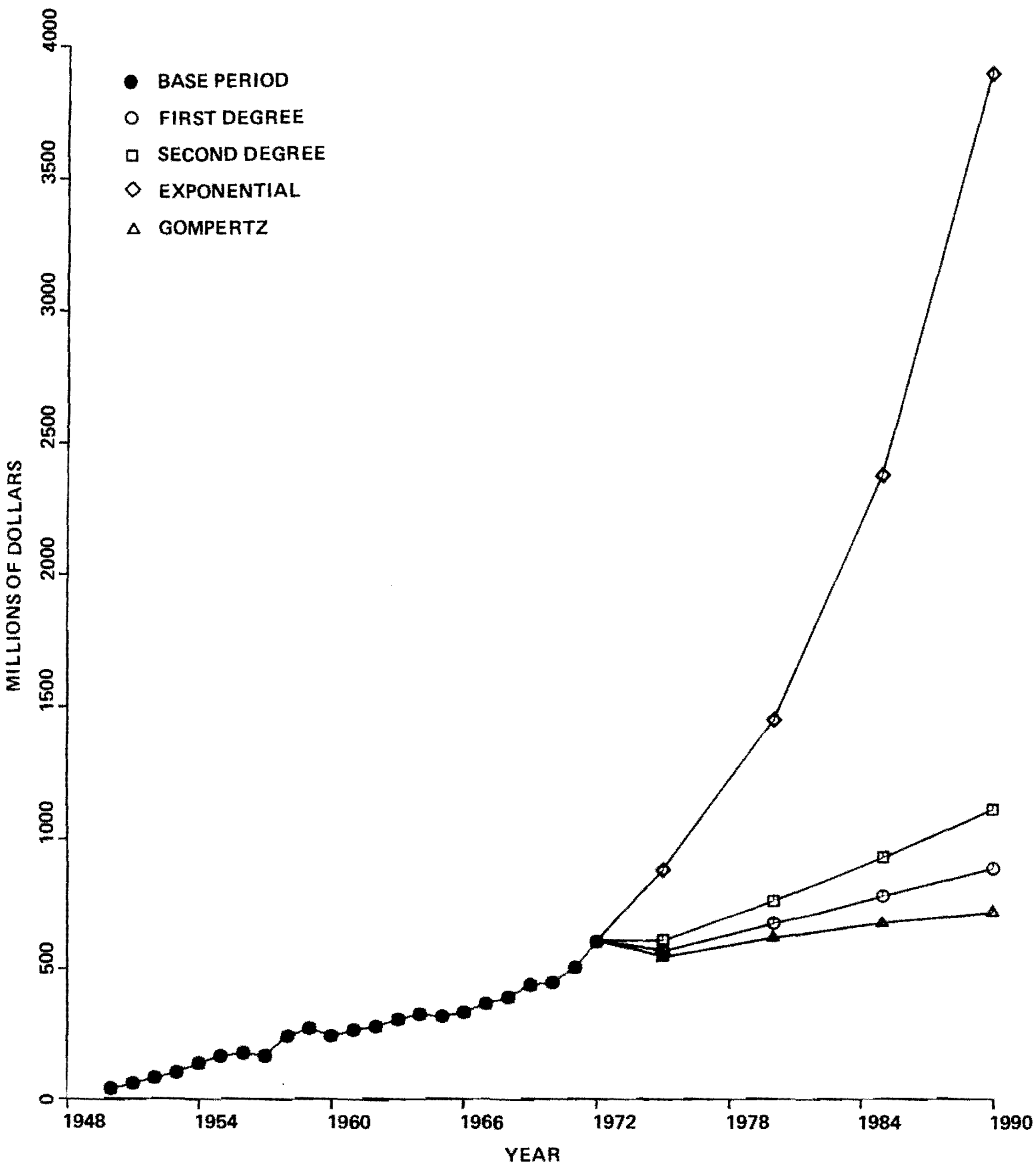

FIGURE B-9. STONE, CLAY, AND GLASS PRODUCTS VALUE ADDED BY MANUFACTURE IN TEXAS EXTRAPOLATIONS

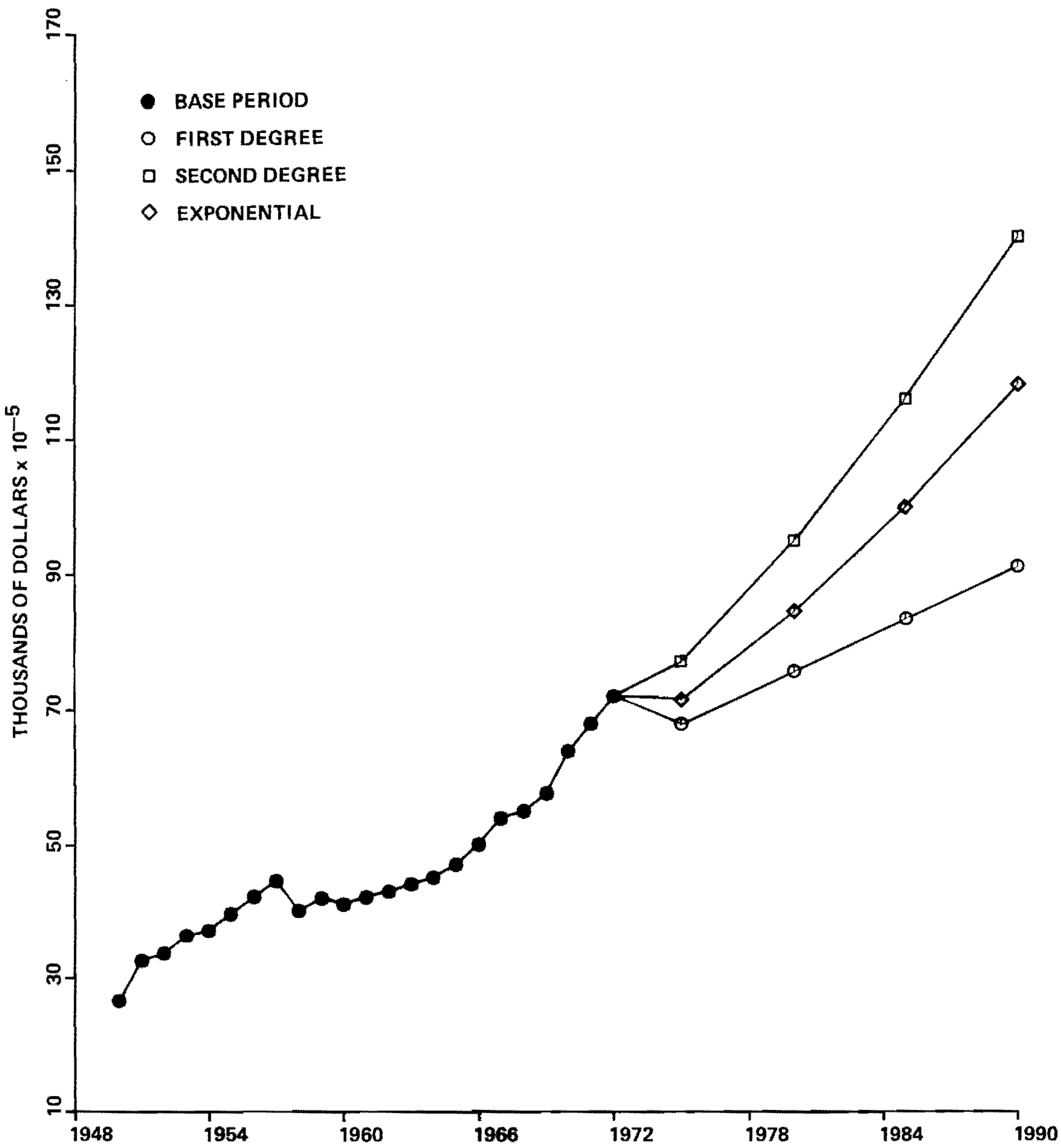

FIGURE B-10. VALUE OF MINERAL PRODUCTION IN TEXAS EXTRAPOLATIONS

RESEARCH MEMORANDA PUBLISHED BY THE COUNCIL FOR ADVANCED TRANSPORTATION STUDIES

1 *Human Response in the Evaluation of Modal Choice Decisions.* C. Shane Davies, Mark Alpert, and W. Ronald Hudson, April 1973.

2 *Access to Essential Services.* Ronald Briggs, Charlotte Clark, James Fitzsimmons, and Paul Jensen, April 1973.

3 *Psychological and Physiological Responses to Stimulation.* D. W. Wooldridge, A. J. Healey, and R. O. Stearman, August 1973.

4 *An Intermodal Transportation System for the Southwest: A Preliminary Proposal.* Charles P. Zlatkovich, September 1973.

5 *Passenger Travel Patterns and Mode Selection.* Shane Davies, Mark Alpert, Harry Wolfe, and Rebecca Gonzalez, October 1973.

6 *Segmenting a Transportation Market by Determinant Attributes of Modal Choice.* Shane Davies and Mark Alpert, October 1973.

7 *The Interstate Rail System: A Proposal.* Charles P. Zlatkovich, December 1973.

8 *Literature Survey on Passenger and Seat Modeling for the Evaluation of Ride Quality.* Bruce Shanahan, Ronald Stearman, and Anthony Healey, November, 1973.

9 *The Definition of Essential Services and the Identification of Key Problem Areas.* Ronald Briggs and James Fitzsimmons, January, 1974.

10 *A Procedure for Calculating Great Circle Distances Between Geographic Locations.* J. Bryan Adair, March 1974.

11 *MAPRINT: A Computer Program for Analyzing Changing Locations of Non-Residential Activities.* Graham Hunter, Richard Dodge, and C. Michael Walton, March 1974.

12 *A Method for Assessing the Impact of the Energy Crisis on Highway Accidents in Texas.* E. L. Frome and C. Michael Walton, February 1975.

13 *State Regulation of Air Transportation in Texas.* Robert C. Means and Barry Chasnoff, April 1974.

14 *Transportation Atlas of the Southwest.* Charles P. Zlatkovich, S. Michael Dildine, Eugene Robinson, James W. Wilson, and J. Bryan Adair, June 1974.

15 *Local Government Decisions and Land-Use Change: An Introductory Bibliography.* W. D. Chipman, May 1974.

16 *An Analysis of the Truck Inventory and Use Survey Data for the West South Central States.* Michael Dildine, July 1974.

17 *Towards Estimating the Impact of the Dallas-Fort Worth Regional Airport on Ground Transportation.* William J. Dunlay and Lyndon Henry, September 1974.

18 *The Attainment of Riding Comfort for a Tracked Air-Cushion Vehicle Through the Use of an Active Aerodynamic Suspension.* Bruce Shanahan, Ronald Stearman, and Anthony Healey, September 1974.

19 *Legal Obstacles to the Use of Texas School Buses for Public Transportation.* Robert Means, Ronald Briggs, John E. Nelson, and Alan J. Thiemann, January 1975.

20 *Pupil Transportation: A Cost Analysis and Predictive Model.* Ronald Briggs and David Venhuizen, April 1975.

21 *Variables in Rural Plant Location: A Case Study of Sealy, Texas.* Ronald Linehan, C. Michael Walton, and Richard Dodge, February 1975.

22 *A Description of the Application of Factor Analysis to Land Use Change in Metropolitan Areas.* John Sparks, Carl Gregory, and Jose Montemayor, December 1974.

23 *A Forecast of Air Cargo Originations in Texas to 1990.* Mary Lee Metzger Gorse, November 1974.

24 *A Systems Analysis Procedure for Estimating the Capacity of an Airport: A Selected Bibliography.* Chang-Ho Park, Edward V. Chambers III, and William J. Dunlay, Jr., August 1975.

25 *System 2000—Data Management for Transportation Impact Studies.* Gordon Derr, Richard Dodge and C. Michael Walton, September 1975.

26 *Regional and Community Transportation Planning Issues—A Selected Bibliography.* John Huddleston, Ronald Linehan, Abdulla Sayyari, Richard Dodge, C. Michael Walton, and Marsha Hamby, September 1975.

27 *A Systems Analysis Procedure for Estimating the Capacity of an Airport: System Definition, Capacity Definition, and Review of Available Models.* Edward V. Chambers III, Tommy Chmores, William J. Dunlay, Jr., Nicolau D. F. Gualda, B. F. McCullough, Chang-Ho Park, and John Zaniewski, October 1975.

28 *The Application of Factor Analysis to Land Use Change in a Metropolitan Area.* John Sparks and Jose Montemayor, November 1975.

Council for Advanced Transportation Studies

THE UNIVERSITY OF TEXAS AT AUSTIN